

Sexual Reproduction in Flowering Plants

CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v) given below:

The pollen grains or microspores are the male reproductive bodies of a flower and are contained in the pollen sac or microsporangia. Each pollen grain consists of a single microscopic cell, possessing two coats : the exine and the intine. The exine of a pollen grain is made of chemically stable material. Because of this, pollen grains are often very well preserved for thousands of years in soil and sediments.

- (i) One of the most resistant biological material present in the exine of pollen grain is
- | | |
|--------------------|-------------------|
| (a) pectocellulose | (b) sporopollenin |
| (c) suberin | (d) cellulose. |
- (ii) The exine possesses one or more thin places known as
- | | |
|-----------|------------------|
| (a) raphe | (b) germ pores |
| (c) hilum | (d) endothecium. |
- (iii) What is the function of germ pore?
- | |
|--|
| (a) Emergence of radicle |
| (b) Absorption of water for seed germination |
| (c) Initiation of pollen tube |
| (d) All of these |
- (iv) What is the key advantage to the plant for having such strong pollen grain walls?
- | |
|--|
| (a) It protects the vital genetic material in the pollen grain. |
| (b) It allows pollen to serve as a valuable fossil record for the study of ancient plants. |
| (c) It prevents the pollen tube from growing out before the pollen grain reaches the stigma of a compatible species. |
| (d) It gives weight to the pollen grain, allowing it to cling better to the body surfaces of insect pollinators. |
- (v) The number of germ pores in dicots and monocots respectively are
- | |
|--------------------|
| (a) one and three |
| (b) three and two |
| (c) two and three |
| (d) three and one. |

Syllabus

Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; outbreeding devices; pollen-pistil interaction; double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes- apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

Read the following and answer any four questions from 2(i) to 2(v) given below:

Cross pollination is the transfer of pollen grains from the anther of a one flower to the stigma of a genetically different flower. It is performed with the help of an external agency which may be abiotic (e.g., wind, water) or biotic (e.g., insects, birds, bats, snails). The diagram shows the carpel of an insect pollinated flower.

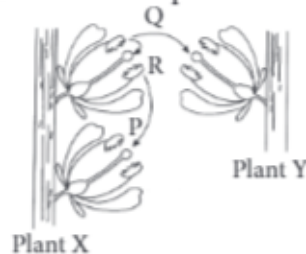


- (i) What is the most likely reason for non germination of pollen grain Z?
- Pollen grains X and Y were brought to the stigma earlier, therefore, their germination inhibited the germination of pollen grain Z.
 - Pollen grain Z was brought to the flower by wind, while pollen grains X and Y were brought to the flower by insect.
 - Pollen grain Z lacks protrusions that allow it to adhere properly onto the stigma surface.
 - Pollen grain Z comes from a flower of an incompatible species.
- (ii) Which of the following best describes the function of the pollen tube?
- It acts as a conduit to transport male gametes from the anther to the ovule.
 - It acts as a conduit to transport male gametes from the stigma to the ovule.
 - It contains key nutrients that serve to nourish the newly-formed zygote.
 - It digests the tissues of the stigma, style and ovary.
- (iii) Pollination of a flower in which the pollen is carried by an insect is called
- anemophily
 - ornithophily
 - entomophily
 - malacophily.
- (iv) Refer to the given characteristics of some flowers.
- The stamens hang out of the flower, exposing the anthers to the wind.
 - The pollen grains are tiny and light.
 - The flower has a sweet scent.
 - The flower petals are brightly coloured.
- How many of the above characteristics are of insect-pollinated flower?
- One
 - Two
 - Three
 - Four
- (v) Pollenkitt is generally found in
- anemophilous flowers
 - entomophilous flowers
 - ornithophilous flowers
 - malacophilous flowers.

Read the following and answer any four questions from 4(i) to 4(v) given below:

In angiosperms, the pollen grains are being transferred from the anther to the stigma and is termed pollination. This phenomenon was first discovered by Camerarius (1694) in the end of seventeenth century. Pollen grains are immobile. They cannot reach the stigma by themselves. An external agent is required for this. The pollination is mainly of two types-self pollination and cross pollination.

The diagram given below shows two plants of the same species showing different types of pollination.



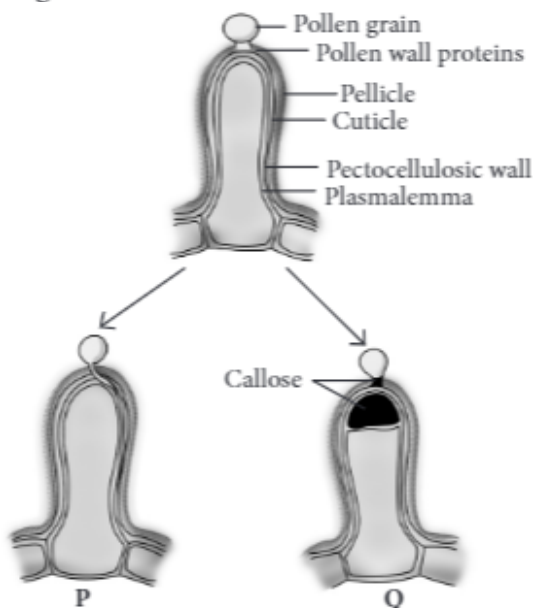
- (i) What is transferred between the plants in the process indicated by arrow P?
 (a) Ova (b) Pollen (c) Nutrients (d) Seeds
- (ii) Which of the following statements is correct regarding processes P, Q and R?
 (a) Processes P, Q and R introduce genetic variability in the offspring of sexually reproducing plants X and Y.
 (b) Wind serves as agent for process Q if plants X and Y belong to Genus *Salvia*.
 (c) Flowers of plants X and Y need to produce odour and nectar for completion of processes P and Q if they are entomophilous.
 (d) If plants X and Y belong to Genus *Cannabis*, then their flowers need to produce sticky and heavy pollens in very small amount for accomplishment of process Q.
- (iii) Identify the processes P, Q and R.
- | P | Q | R |
|-----------------|-------------|-------------|
| (a) Geitonogamy | Xenogamy | Autogamy |
| (b) Allogamy | Chasmogamy | Cleistogamy |
| (c) Autogamy | Geitonogamy | Xenogamy |
| (d) Geitonogamy | Allogamy | Autogamy |
- (iv) In *Catharanthus*, the growth of style brings the stigma in contact of ripe anthers present on the mouth of corolla tube. This is an example of
 (a) homogamy (b) cleistogamy (c) geitonogamy (d) xenogamy.
- (v) Which of the given processes represents a type of pollination that would result in greater adaptability of the particular species to potential environmental changes?
 (a) P (b) Q (c) R (d) All of these

Read the following and answer any four questions from 5(i) to 5(v) given below:

Pollen-pistil interaction is the group of events that occur from the time of pollen deposition over the stigma to the time of pollen tube entry into ovule. It is a dynamic process which has checks at several places for promotion or inhibition of pollen growth. Pollen-pistil interaction is a safety measure to ensure that illegitimate

crossings do not occur. Compatibility and incompatibility of the pollen-pistil is determined by special proteins. The compatible pollens are able to absorb water and nutrients from the surface of the stigma. They germinate and produce pollen tubes. Pollen tubes grow into the style. Their growth and path through the style are also determined by specific chemicals.

- (i) Which of the following parts of gynoecium determines the compatible nature of pollen?
 (a) Stigma (b) Style (c) Ovary (d) Thalamus
- (ii) In *Trifolium*, which type of self-incompatibility is found?
 (a) Gametophytic self-incompatibility (GSI)
 (b) Sporophytic self-incompatibility (SSI)
 (c) Both GSI and SSI
 (d) None of these
- (iii) Select the incorrect statement.
 (a) In Asteraceae, incompatibility is due to the genotype of the sporophytic stigmatic tissues.
 (b) In members of Brassicaceae, incompatibility is due to the genotype of the pollen.
 (c) Nature has imposed self-incompatibility to avoid highly homozygous individuals which have a very low survival value.
 (d) None of these
- (iv) Which of the following are examples of self incompatibility?
 (a) Tobacco (b) Potato (c) Crucifers (d) All of these
- (v) Given figures show the pollen-stigma interaction, where pollen wall proteins are released onto the pellicle of stigmatic papillae, where recognition reaction occurs.



- Which of the following statements drawn from given figures is incorrect?
- (a) P indicates compatible reaction in which the pollen tube penetrates the cuticle and grows down the papilla.
 (b) Development of callose plug between the plasma membrane and pectocellulosic layer of stigmatic papillae results in the incompatibility reaction in Q.
 (c) A callose plug which appears at the tip of pollen in Q, is dissolved by callase enzyme secreted by stigma resulting in compatibility reaction.
 (d) Deposition of callose can be employed as a reliable bioassay to detect compatibility or incompatibility reactions of pollen and stigma.

Read the following and answer any four questions from 6(i) to 6(v) given below:

Apomixis is a mode of reproduction which does not involve formation of zygote through gametic fusion. In plants, apomixis commonly mimics sexual reproduction but produces seeds without fertilisation. There are several methods of apomictic development in seeds. The two common ones are recurrent agamospermy and adventive embryony.

- (i) Apomixis is a type of reproduction in plants in which
- fertilisation does not take place
 - male nucleus takes part in fertilisation
 - pollen fusion takes place
 - generative nucleus takes part in fertilisation.
- (ii) Which of the following statements is incorrect regarding recurrent agamospermy?
- It is the formation of seed that has an embryo formed without meiosis and syngamy.
 - All the cells of embryo sac are diploid.
 - An embryo develops directly from a diploid cell other than egg like that of nucleus and integument.
 - None of these
- (iii) Adventive embryony is found in
- | | |
|-------------------|-----------------------|
| (a) <i>Citrus</i> | (b) <i>Opuntia</i> |
| (c) Apple | (d) Both (a) and (b). |
- (iv) Formation of embryo directly from diploid egg without fertilisation is called
- apospory
 - diplospory
 - polyembryony
 - diploid parthenogenesis.
- (v) If any somatic cell of sporophyte produces gametophyte without reduction division, it is called
- parthenogenesis
 - apogamy
 - apospory
 - amphimixis.

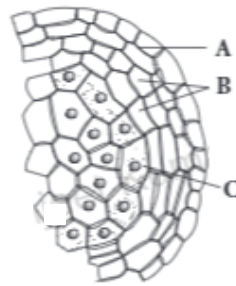
Read the following and answer any four questions from 7(i) to 7(v) given below:

The anther is a four-sided structure consisting of four microsporangia located at the corners two in each lobe. The microsporangia develop further and become pollen sacs. In a transverse section, a typical microsporangium appears near circular in outline. It is generally surrounded by four wall layers-the epidermis, endothecium, middle layers and the tapetum.

- (i) A dithecous anther consists of (A) microsporangia, (B) in each lobe.
Select the option that correctly fills the blanks.

A	B
(a) four	two
(b) two	one
(c) two	two
(d) four	one

(ii) The given diagram shows microsporangium of a mature anther. Identify A, B and C.



- | | | |
|--------------------|----------------|----------------|
| (a) A-Middle layer | B-Endothecium | C-Tapetum |
| (b) A-Endothecium | B-Tapetum | C-Middle layer |
| (c) A-Endothecium | B-Middle layer | C-Tapetum |
| (d) A-Tapetum | B-Middle layer | C-Endothecium |

(iii) The function of labelled part X is



- | | | | |
|----------------|----------------|---------------|-----------------|
| (a) dehiscence | (b) mechanical | (c) nutrition | (d) protection. |
|----------------|----------------|---------------|-----------------|

(iv) Select the incorrect statement.

- Microsporangium is generally surrounded by four wall layers-epidermis, endothecium, middle layers and tapetum.
- Outer three layers perform functions of protection and dehiscence of anthers.
- Cells of tapetum possess dense cytoplasm and generally have more than one nucleus.
- Cells of tapetum undergo meiosis and produce microspore tetrads.

(v) Which function of tapetum is correct?

- Helps in pollen wall formation.
- Transportation of nutrients to inner side of anther.
- Synthesis of callase enzyme for separation of microspore tetrads.
- All of these

8

Read the following and answer any four questions from 8(i) to 8(v) given below:

The endosperm makes the main source of food for the embryo. Generally the endosperm nucleus divides after the division of the oospore, but in several cases the endosperm is formed to a great extent even before the first division of the oospore. There are three general types of endosperm formation : (a) nuclear type, (b) cellular type and (c) helobial type. The endosperm is usually triploid but haploid endosperm is also found. Endosperm may either be completely consumed by the developing embryo before seed maturation or it may persist in the mature seed.

(i) Haploid endosperm is found in

- | | | | |
|------------------|-----------------|---------------|----------|
| (a) <i>Pinus</i> | (b) cauliflower | (c) sunflower | (d) pea. |
|------------------|-----------------|---------------|----------|

(ii) Persistent endosperm is found in

- | | | | |
|--------------|-------------|----------------|-----------------|
| P. Pea | Q. Castor | R. Bean | S. Coconut |
| T. Groundnut | | | |
| (a) Q and S | (b) P and T | (c) R, S and T | (d) P, S and T. |

(iii) Milk of tender coconut represents (i) and the surrounding white coconut meal represents (ii) .

(i) (ii)

- (a) cellular endosperm free-nuclear endosperm
- (b) free-nuclear endosperm cellular endosperm
- (c) helobial endosperm cellular endosperm
- (d) free-nuclear endosperm helobial endosperm

(iv) If an endosperm cell of a gymnosperm contains 12 chromosomes, the number of chromosomes in each cell of the root will be

- (a) 4 (b) 24 (c) 16 (d) 6.

(v) In angiosperms, normally after fertilisation

- (a) the zygote divides earlier than the primary endosperm nucleus
- (b) the primary endosperm nucleus divides earlier than the zygote
- (c) both the zygote and primary endosperm nucleus divide simultaneously
- (d) both the zygote and primary endosperm nucleus undergo a resting period.

9

Read the following and answer any four questions from 9(i) to 9(v) given below:

Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divided only after certain amount of endosperm is formed. The early stages of embryo development are similar in both monocotyledons and dicotyledons. The zygote gives rise to the proembryo and subsequently to the globular heart-shaped and mature embryo. A typical dicotyledonous embryo consists of an embryonal axis and two cotyledons. Embryo of monocotyledons possess only one cotyledon.

(i) True embryo develops as a result of fusion of

- (a) two polar nuclei of embryo sac
- (b) an egg cell and a male gamete
- (c) synergid and male gamete
- (d) a male gamete and antipodals.

(ii) Refer to the given diagram of the embryo of an angiospermous plant with parts labelled P, Q and R. Select the correct statement(s) regarding this.



- (i) Part 'P' supplies nutrition to the developing embryo.
 - (ii) Part 'Q' is the protective sheath of radicle and root cap.
 - (iii) Part 'R' is the protective sheath of shoot apex and leaf primordia.
 - (iv) The embryo shown in the diagram is present in members of Family Poaceae.
- (a) (iv) only (b) (ii) and (iii) only
(c) (i) and (iv) only (d) (i), (ii), (iii) and (iv)

(iii) Which of the given statements are true?

- (i) During the development of a dicot embryo, heart-shaped embryo is followed by globular embryo.
- (ii) The part of embryonal axis above the level of cotyledons is epicotyl, while the part below the level of cotyledons is hypocotyl.

(iii) Monocot seeds possess a single cotyledon represented by scutellum.

- (a) (i) and (ii)
- (b) (ii) and (iii)
- (c) (i) and (iii)
- (d) (i), (ii) and (iii)

(iv) Consider the following parts of an embryonal axis of a dicot seed.

- (i) Hypocotyl
- (ii) Epicotyl
- (iii) Radicle
- (iv) Plumule

In which of the following the above parts are correctly arranged from top to base?

- (a) (iii) → (i) → (ii) → (iv)
- (b) (ii) → (i) → (iii) → (iv)
- (c) (iv) → (ii) → (i) → (iii)
- (d) (iii) → (iv) → (ii) → (i)

(v) In grass family, the cotyledon is called

- (a) epiblast
- (b) plumule
- (c) scutellum
- (d) perisperm.

10

Read the following and answer any four questions from 10(i) to 10(v) given below:

A typical angiospermic ovule is a small structure attached to the placenta by means of a stalk called funicle. The body of the ovule fuses with funicle in the region called hilum. Each ovule has one or two protective envelopes called integuments. Integuments encircle the nucellus except at the tip where a small opening called the micropyle is formed. Mature ovules are classified on the basis of funiculus. It can be orthotropous, anatropous, hemitropous, campylotropous, etc.

(i) The body of the ovule consists of a mass of parenchymatous cells called

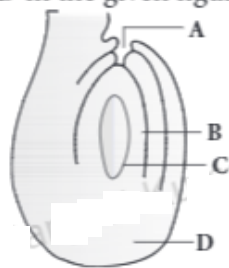
- (a) integuments
- (b) nucellus
- (c) hilum
- (d) funiculus.

(ii) Refer to the given figure and select the correct statement regarding it.



- (a) This type of ovule is found in cactus.
- (b) The micropyle comes to lie close to the funiculus due to unilateral growth of ovule.
- (c) It is most common type of ovule found in the members of Chenopodiaceae.
- (d) It is half inverted ovule.

(iii) Identify the parts labelled as A, B, C and D in the given figure and select the correct option.



A	B	C	D
(a) Chalaza	Female gametophyte	Embryo sac	Micropyle
(b) Chalazā	Nucellus	Embryo sac	Micropyle
(c) Micropyle	Egg	Embryo sac	Chalaza
(d) Micropyle	Nucellus	Embryo sac	Chalaza

(iv) Mature ovules are classified on the basis of funiculus. If micropyle lie close to the funiculus, the ovule is termed as

- (a) orthotropous (b) anatropous (c) hemitropous (d) campylotropous.

(v) In *Asphodelus*, ovule is

- (a) unitegmic (b) tritegmic (c) bitegmic (d) ategmic.

ASSERTION & REASON

For question numbers 11-30, two statements are given—one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Both assertion and reason are false

11. **Assertion :** Perisperm is protective covering of seed and helps in dispersal and nutrition.

Reason : Pericarp is covering of fruit which is non-functional.

12. **Assertion :** Ubisch bodies are produced by glandular tapetum.

Reason : Ubisch bodies participated in the thickening of exine.

13. **Assertion :** Anemophily is non-directional.

Reason : Entomophily is highly specific and directional.

14. **Assertion :** One pollen mother cell forms four microspores.

Reason : Microspores are formed due to reduction division.

15. **Assertion :** Mostly in a tetrad, all microspores are free.

Reason : Compound pollen grain and pollinium are formed by grouping of microspores.

16. **Assertion :** Pollen wall is made up of two walls the intine and the exine.

Reason : Both the walls have depositions of sporopollenin.

17. **Assertion :** Pollen grains of many insect pollinated species are sticky.

Reason : In the anemophilous flower, the pollen grains are powdery and non-sticky.

18. **Assertion :** Nucellus functions as a nutritive tissue.

Reason : Nucellus is always exhausted completely during development of embryo sac.

19. **Assertion :** Placenta is tissue present inside the ovary.
Reason : Placenta bears ovules.
20. **Assertion :** Megaspore mother cell undergoes meiotic division.
Reason : All four megaspores form female gametophyte.
21. **Assertion :** The egg apparatus, consists of two synergids and one egg cell.
Reason : Filiform apparatus play an important role in guiding the pollen tubes into the synergids.
22. **Assertion :** Chasmogamous flowers require pollinating agents.
Reason : Cleistogamous flowers do not expose their sex organs.
23. **Assertion :** Cross pollination is the only means of pollination in unisexual flowers.
Reason : Self-sterility is the only way to prevent self-pollination in bisexual flowers.
24. **Assertion :** Allogamy includes both geitonogamy and xenogamy.
Reason : Allogamy needs abiotic or biotic external agencies for pollination.
25. **Assertion :** Most of entomophilous pollination is done by bees.
Reason : Bee-pollinated flowers are highly coloured.
26. **Assertion :** *Colpa aurea* is a specialised pollinating agent of orchid *Ophrys speculum*.
Reason : Male *Colpa* mistakes the *Ophrys* flowers for female partner.
27. **Assertion :** Self-sterility inhibits self pollination.
Reason : Dichogamy is the condition in which only self pollination occurs.
28. **Assertion :** Double fertilization is unique to angiosperms.
Reason : Triple fusion occurs in both fertilization, *i.e.* first and second.
29. **Assertion :** In angiosperms, the first fertilization is called syngamy.
Reason : Second fertilization is called vegetative fertilization.
30. **Assertion :** Helobial endosperm is found in monocots.
Reason : Two chambers are formed in this endosperm.

HINTS & EXPLANATIONS

1. (i) (b) : Outer layer (exine) of pollen grain is made of a highly resistant substance called sporopollenin. It is not degraded by any enzyme and not affected by high temperature, strong acid or strong alkali.
(ii) (b)
(iii) (c) : One or more thin areas present in the exine of pollen grains are known as germ pores. The germ pores are apertures in the exine layer of the pollen grain where the sporopollenin is absent. The germ pore helps in the formation of the pollen tube and the release of the male gametes during fertilisation. There are usually three germ pores in dicots (tricolpate) and one in monocots (monocolpate).
(iv) (a) : The pollen grain wall helps to protect the male gametes from drying up or chemical attack, thus protecting the DNA in the male gametes. This helps to maintain the integrity of genetic material that would be inherited by subsequent generations.
(v) (d) : Refer to answer 1(iii).
2. (i) (d) : Pollen grains can only germinate if the pollen grain and style tissues are compatible, *i.e.*, of the same or closely related species. Pollen grains X and Y must have come from a compatible species.
(ii) (b)
(iii) (c) : Entomophily is the type of pollination that takes place through the agency of insects. The insect-loving flower possesses various adaptations by which they attract insects and use them as carrier of pollen grains for the purpose of cross pollination.
(iv) (b) : Insect-pollinated flowers produce nectar, which attract the pollinators for feeding. Some flowers produce edible pollen grains. Flowers are fragrant and emit scent and odour. These are brightly coloured. The pollen grains are spiny, heavy and surrounded by a yellow sticky substance called pollenkitt.
(v) (b) : Refer to answer 2(iv).

3. (i) (b) : Y is a vascular bundle comprising xylem that transports water and mineral salts to the anther, and phloem that transports sugars to the anther.

(ii) (b) : X contains pollen grains. Pollen grain contains two haploid nuclei resulting from mitosis, a generative nucleus and pollen tube/vegetative nucleus.

(iii) (c) : Rough surfaces on pollen grains help them to cling onto the surface of insect pollinators.

(iv) (b) : Insect-pollinated plants tend to have pollen with rough surfaces to allow them to cling more readily onto the body of insect pollinators. Their stamens are unlikely to be pendulous nor protrude outside the flower, since the pollen is not intended to be released into the air and carried away by the wind.

(v) (b) : Entomophily type of pollination takes place through the agency of insects. The entomophilous flowers are brightly coloured and fragrant to attract the insects. Their pollen grains are sticky or spiny to easily get attached with the body of pollinators. When the insects visit the flowers, their body gets dusted with pollen grains, and when they fly and visit other flowers, they brush against the stigma which being sticky, at once receives the pollen grains from their body. Thus, cross-pollination is achieved.

4. (i) (b)

(ii) (c) : In the given figure, processes P, Q and R represent geitonogamy (self pollination), xenogamy (cross pollination) and autogamy (self pollination), respectively. Pollinating agents are required for accomplishment of processes P and Q but no agent is required for process R. Out of P, Q and R, only Q is responsible for introducing genetic variability as it is cross pollination between different plants of same species. *Salvia* is insect pollinated whereas *Cannabis* is wind pollinated plant.

(iii) (a) : Refer to answer 4(ii).

(iv) (a) : Homogamy occur in chasmogamous or open flowers where anthers and stigmas are brought together by growth, bending or folding.

(v) (b)

5. (i) (a) : Stigma is the terminal receptive part of the pistil which functions as landing platform for the pollen grains. It also determines the compatibility of the pollen grains.

(ii) (a)

(iii) (b) : In members of Brassicaceae, incompatibility is due to the genotype of the sporophytic stigmatic tissues.

(iv) (d)

(v) (c) : The most distinct response of the stigma to an incompatible pollen is the development of callose plug between the plasma membrane and pectocellulosic layer of the stigmatic papillae, just below the point of contact with the pollen; a callose plug also appears at the tip of the pollen tube. With the appearance of the callose-plug, the growth of the pollen tube ceases. The deposition of callose in the stigmatic cells can be employed as a reliable bioassay to detect incompatible pollen particularly where the rejection occurs on the stigma. This bioassay has served as a useful aid in providing direct evidence for the involvement of exine-borne proteins in incompatibility reaction.

6. (i) (a)

(ii) (c) : In recurrent agamospermy all the cells of embryo sac are diploid as it is formed directly either from a nuclear cell or diploid megaspore mother cell.

(iii) (d) : In adventive embryony, an embryo develops directly from a diploid cell other than egg like that of nucleus and integument, e.g., *Citrus*, *Opuntia*.

(iv) (d) : Formation of embryo directly from diploid egg without fertilisation is called diploid parthenogenesis. It is found in *Rubus*, apple, *Poa*.

(v) (c)

7. (i) (a) : A typical angiosperm anther is bilobed with each lobe having two theca, i.e., dithecous and a dithecous anther is tetrasporangiate having four microsporangia, two in each lobe.

(ii) (c)

(iii) (c) : The tapetal layer is of great physiological significance as all the food material entering into the sporogenous tissue diffuses through this layer. Ultimately the cells of tapetal layer disorganise. Thus, tapetum makes a nutritive layer for the developing microspores or pollen grains.

(iv) (d)

(v) (d) : Tapetum secretes Ubisch bodies which get covered with sporopollenin and so increase thickness of exine of pollen grain wall. Tapetum provides nourishment to developing microspores. It also secretes callase enzyme which dissolves callose substances by which four pollens of a pollen tetrad are united, hence separating microspores or pollens of a tetrad.

8. (i) (a) : In gymnosperms, the endosperm is haploid (n) and forms a continuation of the female gametophyte.

(ii) (a) : In some seeds, the endosperm persists in the seed as food storage tissue. Such seeds are called endospermic or albuminous, e.g., castor, maize, wheat, barley, rubber and coconut.

(iii) (b) : In coconut (*Cocos nucifera*), the surrounding white kernel called coconut meal is cellular endosperm and the coconut water (also called coconut milk) in the centre is free nuclear endosperm made up of thousands of nuclei.

(iv) (b) : The endosperm of a gymnosperm is haploid (n), while the cells of the root are diploid (2n). So, the number of chromosomes in the root will be 24.

(v) (b)

9. (i) (b) : In double fertilisation, out of the two male gametes one fuses with egg or oosphere to perform generative fertilisation. Generative fertilisation is also called syngamy or true fertilisation. It gives rise to a diploid zygote or oospore.

(ii) (c)

(iii) (b) : During the development of dicot embryo, initially the dicot embryo is globular and undifferentiated. Early embryo with radial symmetry is called proembryo. It is transformed into embryo with the development of radicle, plumule and cotyledons. Two cotyledons differentiate from the sides with a faint plumule in the centre. At this time the embryo becomes heart-shaped.

(iv) (c)

(v) (c) : In the grass family, the cotyledon is called scutellum that is situated towards one side (lateral) of the embryonal axis.

10. (i) (b)

(ii) (a) : The given figure is of circinotropous ovule where funiculus coiled around the ovule. It is found in the Family Cactaceae.

(iii) (d) : Given figure represents an anatropous ovule where A, B, C and D represent micropyle, nucellus, embryo sac and chalaza respectively.

(iv) (b) : Depending upon the configuration and orientation of the body of ovule in relation to funiculus, there are six types of ovule – orthotropous (atropous, erect), anatropous (inverted), hemitropous (half inverted), campylotropous (body curved), amphitropous (both body and embryo sac curved) and circinotropous (funiculus coiled around the ovule).

Anatropous or inverted ovule is the most common type of ovule found in angiosperms (in 80% of angiosperm families). Here, body of the ovule gets inverted and micropyle is on lower side. Further micropyle and funiculus lie side by side and micropyle is close to hilum.

(v) (b)

11. (d) : Perisperm is unused nucellus in the seed. It is often non functional for seed. Pericarp is the covering of fruit that develops from ovary wall. It is protective covering and also helps in dispersal and nutrition.

12. (b) : The Ubisch bodies are produced only by the glandular tapetum. Ubisch bodies get covered with sporopollenin and thus increase thickening of exine. The Ubisch bodies are involved in the external thickening of the exine, whose pattern is laid down by the spore cytoplasm in the tetrad stage.

13. (b)

14. (a) : The sporogenous cells of anther may directly function as microspore mother cells (also called pollen mother cells or PMCs) or they may undergo a few mitosis to add up to their number before entering meiosis. Each PMC, by a meiotic division, gives rise to a group of four haploid microspores. The aggregates of four microspores are referred to as microspore tetrads.

15. (b) : Mostly all the four spores within a tetrad are completely isolated from one another and from the spores in other tetrads of the locule. Usually the microspores separate from one another shortly after meiosis. However, in some plants the spores tend to remain together in tetrads for longer period and develop into compound pollen grains. In many members of Orchidaceae and Asclepiadaceae all the microspores in a sporangium remains together to form what is called a pollinium.

16 (c) : The pollen wall comprises two principal layers, the inner one is called intine and the outer exine. The intine is pecto-cellulosic in nature as is the primary wall of the somatic cells. The exine is composed chiefly of a class of material called sporopollenin.

17. (b)

18. (c) : The body of the ovule consists of a mass of parenchymatous cells named nucellus. The nucellus is mostly consumed by the developing embryo sac or endosperm. But in some plants it persists in the mature seed as a nutritive tissue. The persistent nucellus is called perisperm.

19. (b) : Placenta is a ridge of tissue in the inner wall of the ovary bearing one or more ovules and the manner of distribution of the placenta within the ovary is called placentation.

20. (c): One hypodermal nucellar cell of the micropylar region differentiates into sporogenous cell. It forms a diploid megaspore mother cell or megasporocyte. The megaspore mother cells undergo meiosis and forms a row of four haploid megaspores. Only the chalazal megaspore remains functional while the other three degenerate. The functional megaspore enlarges and gives rise to female gametophyte, also called embryo sac.

21. (b)

22. (b): The majority of angiosperms bear chasmogamous flowers, which means the flowers expose their mature anthers and stigma to the pollinating agents. There is another group of plants which set seeds without exposing their sex organs. Such flowers are called cleistogamous and the phenomenon is cleistogamy. Such flowers show self pollination.

23. (c): In plants such as hemp and willow where the flowers are unisexual cross pollination becomes obligatory. However, in plants with bisexual flowers legitimate self-pollination is prevented through the various adaptations, such as self-sterility, dichogamy, herkogamy and heterostyly. All those plants in which pollen from a flower is incapable of bringing about fertilization in the same flower are said to be self sterile or self-incompatible.

24. (b): Cross pollination is the transfer of pollen grains from the anther of one flower to the stigma of another flower, *i.e.*, allogamy. Cross pollination is further classified depending on whether the pollination has occurred between two flowers on the same plant (geitonogamy) or between two flowers on different plants (xenogamy). Cross pollination (allogamy) is performed with the help of an external agency. The latter may be abiotic (*e.g.*, wind, water) or biotic (*e.g.*, insects, birds, bats, snails).

25. (b): Of the various insects, bees are the main flower visitors. Bees handle up to 80% of all pollination done by insects. All the bee pollinated flowers are brightly coloured, possess sweet fragrance, and / or produce nectar. Bees are colour blind for red and are fond of yellow, violet and purple. The bees visit flowers to collect their food (pollen and nectar) and in the process prove instrumental in bringing about pollination.

26. (a): For its pollination the orchid *Ophrys speculum* has picked on the most selective attraction in the entire

animal kingdom. It is pollinated by a hairy wasp, *Colpa aurea*. The wasp has a fixed habit whereby its males leave the burrows for above-ground existence about four weeks before the females emerge for the open air mating. The orchid opens its flowers about the same time the males appear and they possess an appearance and odour similar to those possessed by the female wasp. The inexperienced males mistake the *Ophrys* flowers for their female counterparts and land to perform the act of pseudo-copulation. The insect repeats the act with a number of orchid flowers and carries pollinia from one flower to another.

27. (c): Self-sterility is the condition in which the pollen of a flower has no fertilizing effect on the stigma of the same flower. Cross-pollination is thus the only method in them for the production of seeds. In many bisexual flowers the anther and stigma often mature at different times. This condition is known as dichogamy. Dichogamy often stands as a barrier to self pollination. There are two conditions of dichogamy. (i) protogyny when the gynoecium matures earlier than the anthers of the same flowers (ii) protandry - when the anthers mature earlier than the stigma of the same flower. In both cases only cross pollination is possible.

28. (c): S.G. Nawaschin (1898) was the first to show that both the sperms released by a pollen tube are involved in fertilization. They fertilize two different elements of the embryo sac. The phenomenon is unique to angiosperms and is called double fertilization. The nucleus of one of the sperms fuses with the egg nucleus (syngamy) and that of the other migrates to the central cell where it fuses with two polar nuclei or their fusion product, the secondary nucleus. The second fertilization involves the fusion of three nuclei (sperm with two polar nuclei). This phenomenon is called triple fusion.

29. (b): Fusion of the egg nucleus with sperm nucleus is called syngamy. As, in this process fusion product is diploid zygote or oospore, it is called generative fertilization. It is also called first fertilization as the first sperm fuses with the egg. The second male gamete fuses with the diploid secondary nucleus of the central cell to form a triploid primary endosperm cell. It is known as vegetative fertilization.

30. (b): Helobial endosperm is restricted largely to the monocotyledons. The primary endosperm nucleus moves to the chalazal end of the embryo sac where it divides forming a large micropylar chamber and a small chalazal chamber.